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Experimental study on interior temperature variation characteristics of rock-like material during the freeze-thaw cycle

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Atmospheric temperatures, which always subject to the cycling with above and below the 0°C isotherm in cold regions, will cause the temperature fluctuations of subsurface rocks due to the heat transport phenomenon. In this study, an series of experiments of rock-like samples were measured to analysis the interior temperature changes of rock specimens under the dry and water-saturated conditions. The interior temperature change characteristics at the surface and center of rock-like materials with temperature cycling from 20 [U+2103] to -20 [U+2103] were observed comprehensively. Based on the experimental results, the impact of water-ice phase changes on the heat conduction relaxation mechanism was detailed discussed from the water-ice micro structure viewpoint. Finally, the heat conduction equations considering the effect of latent heat during phase transition were proposed combining with the heat transport theory and measured data. The experiment and theoretical results could be concluded as follows, the temperature variation curves of dry quasi-sandstone samples presented the negative exponential feature. Moreover, the closer to the boundary, the more sensitivity of temperature changing rate. While the temperature variation of saturated samples represented an obvious three-stage condition. It was clearly illustrated that the temperature changed to be slowdown and a temperature platform appeared in this period of water-ice phase change from 0 [U+2103] to -4 [U+2103]. Meanwhile, the transformation of water molecules structures at the period of phase change can be explained well the mechanism of thermal conductivity relaxation, which was regarded as the essential of latent heat of water altering to ice. the thermal conduction equations can be reflected to the temperature changing process and represented as a theoretical solution to show the three stages of solid phase, liquid phase and phase transition during the freeze and thaw cycles.